REMARKS

A. STATUS OF THE CLAIMS

Claims 1-34 are pending in this application. Claims 23-34 have been withdrawn from consideration. Applicant recognizes that the Office has allowed claims 13-22.

Claims 1-3 and 8-12 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-11 of U.S. Patent No. 5,994,761. Claims 1, 4, 6, and 7 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 3,860,947 ("Gamo"). Claims 5 and 8-12 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Gamo. Claims 2 and 3 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Gamo in view of U.S. Patent No. 5,731,626 ("Eaglesham et al."). Claim 12 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Gamo in view of U.S. Patent No. 5,645,736 ("Allman"). Claims 1 and 4-11 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Temple et al., *Optimizing Carrier Life Profile for Improved Trade-off Between Turn-off Time and Forward Drop*, IEEE Electron Device, July 19, 1983 ("Temple et al.") in view of Gamo. Claims 2 and 3 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Temple in view of Gamo and further in view of Eaglesham et al. Claim 12 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Temple in view of Gamo and further in view of Allman.

B. AMENDMENTS

The Specification is amended at page 18 to correct the unit of platinum concentration used in describing a region of a silicon wafer which extends from a surface of the wafer into the bulk of the wafer. Applicant intended to use atoms/cm^3 as the unit to describe the concentration of platinum in the volume of this region, but mistakenly used atoms/cm^2. It is axiomatic that the concentration of platinum atoms in a three-dimensional wafer region should have units of atoms per volume and not atoms per area. Further support for the use of atoms/cm^3 in this paragraph may be found in the Drawings, especially Figure 7 in which Curve B corresponds to platinum concentration as a function of wafer depth for a wafer produced in accordance with the embodiment described in the amended paragraph.

Claims 1, 6, and 7 have been amended. Support for amended claim 1 may be found in the Specification, for example at page 15, lines 18-22, and in Figure 2.

Support for amended claims 6 and 7 may be found in the Specification, for example in the amended paragraph beginning at page 18, line 16.

C. REJECTION UNDER OBVIOUSNESS-TYPE DOUBLE PATENTING DOCTRINE

Applicant requests reconsideration of the rejection of claims 1-3 and 8-12 of this application under the judicially created doctrine of obviousness-type double patenting over claims 1-11 of U.S. Patent No. 5,994,761 ("the '761 patent"). The present invention as described in amended claim 1 is distinguishable from claim 1 of the '761 patent because amended claim 1 of this application is directed to a silicon segment **comprising minority carrier recombination centers** whereas claim 1 of the '761 patent is directed to a wafer **comprising crystal lattice vacancies**. The phrases, "concentration of the centers" and "crystal lattice vacancies concentration," do not have the same meaning because crystal lattice vacancies are not minority carrier recombination centers, regardless of their respective concentration profiles. The claims of this application are now further distinguishable with regard to these concentration profiles in that amended claim 1 of this application now requires the concentration of centers generally decrease from a peak concentration in the direction of each parallel surface whereas claim 1 of the '761 patent only requires that the concentration of vacancies decrease from a peak in the direction of one of the surfaces. Claims 2, 3 and 8-12 depend from amended claim 1 of this application and claims 2-6, 8, 9, and 11 depend from claim 1 of the '761 patent. Therefore claims 2, 3, and 8-12 of this application are not obvious over claims 2-6, 8, 9, and 11of the '761 patent for the same reasons given above for amended claim 1 of this application.

D. REJECTION OF CLAIM 1 UNDER 35 U.S.C. §§102(b) and §103(a)

Applicant requests reconsideration of the rejections of claim 1 as being anticipated by Gamo and as being unpatentable over Temple et al. in view of Gamo. Claim 1 as amended is directed to a single crystal silicon segment having a non-uniform distribution of minority carrier recombination centers, with the centers having a concentration profile in which the peak density of the centers is at or near the central plane with the **concentration generally decreasing from the position of peak density in both the direction of the front surface and the direction of the back surface of the segment.**

Gamo is directed to a semiconductor switching device with a central region having impurities for controlling the lifetime of carriers. Gamo, however, does not

disclose or suggest a segment with the concentration of centers decreasing from a peak at or near the center in the direction of each of two major parallel surfaces, as described in amended claim 1. On the contrary, as depicted in Figures 1b and 3, Gamo discloses a device with the concentration of centers generally decreasing in the direction of one surface but **generally increasing in the direction of the opposite surface**. Thus, Gamo does not anticipate claim 1 as amended.

Temple et al. also does not anticipate amended claim 1. The Office admits that Temple does not teach a thyristor device comprising a single silicon segment. Additionally, while Temple et al. **propose** a thyristor structure with a low lifetime region[1], they did not prepare such a structure nor did they disclose how to make their own structure, much less how to make the silicon segment described in claim 1. The absence of an actual device is indicated in the introduction to the paper,

> We describe the **proposed structures** and comment on the results of our feasibility study which, to date, is **based primarily on exact computer modeling**. **Preliminary device studies** are underway.[2]

Thus, the Temple et al. reference alone is deficient and does not anticipate amended claim 1.

Although Gamo discloses a device comprising a single-crystal silicon wafer, Gamo does not cure the remaining deficiencies of Temple et al. Specifically, Gamo does not disclose or suggest how to prepare the proposed structure of Temple et al., *i.e.* how to introduce a low lifetime region near the middle of its n-base[3]. To the contrary, Gamo merely purports to disclose a process to reduce the concentration of centers from one surface of a device in the direction of an opposite surface, such that the concentration of centers decreases from one boundary of a central region in the direction of an opposite boundary. Significantly, since this concentration gradient is prepared by retarding the diffusion of a metal contaminant in a single direction through a device[4], Gamo does not disclose a means to provide a central peak in the

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[1]Temple et al., Figure 4.

[2]Temple et al., at 782, emphasis added.

[3]Temple et al., at 783.

[4]"The phosphorous doping layer . . . serves to lower the concentration of gold atoms on that side where the layer is applied . . . relative to the concentration of gold atoms on that side where the layer is not applied." (Gamo, at column 8, lines 17-23) Figure 3 depicts the concentration profile of the device disclosed by Gamo. (Gamo, at column 8, lines14-16.)

b

concentration of centers in a device as proposed by Temple et al. and described by amended claim 1. Stated another way, Gamo teaches away from a device in which the peak density of the centers is at or near the central plane with the concentration generally decreasing from the position of peak density in the direction of **both** opposite surfaces because Gamo expressly teaches a process for preparing a device in which the concentration **increases** from the surface where the gold is diffused into the device in the direction of one of the surfaces, as shown in Figure 3. Thus, claim 1 is patentable over Gamo, alone or in combination with Temple et al.

E. REJECTION OF CLAIMS 4, 6, and 7 UNDER 35 U.S.C. §§102(b)

Applicant requests reconsideration of the rejections of claims 4, 6, and 7 as being anticipated by Gamo. Claims 4, 6, and 7 depend from claim 1 as amended, and are therefore not anticipated by Gamo for the reasons given above for amended claim 1.

Claim 4 is further directed to a silicon segment having a thickness ranging from about **500 microns to about 800 microns**. Claim 4 is additionally distinguishable from Gamo because Gamo fails to disclose or suggest a device having a thickness within the range described by claim 4. Rather, Gamo discloses a wafer having a central layer selected to be from several ten to several hundred microns, and the sole example of a wafer with this central layer is a wafer which is **330 microns** thick (column 6, lines 50-56). Therefore, Gamo does not anticipate claim 4.

Claims 6 and 7 as amended are further directed to a silicon segment wherein the concentration of minority carrier recombination centers in the surface layer is less than about **1×10^{11} and 1×10^{13} centers/cm^3** respectively. Gamo fails to disclose or suggest the concentrations in the surface layer as described in claims 6 and 7 as amended. Although Gamo Figure 3 is cited by the Office as disclosing a surface layer concentration less than **1×10^{16} atoms/cm^3**, this amount is orders of magnitude higher than the maximum concentrations described in amended claims 6 and 7. Additionally, the ordinate axis is not labeled with the units of concentration. Accordingly, Gamo cannot be said to disclose **any** concentration of impurities. Gamo, therefore, does not anticipate claims 6 and 7 as amended.

E. REJECTION OF CLAIMS 2-12 UNDER 35 U.S.C. §§102(b) and §103(a)

Gamo

Applicant requests reconsideration of the rejection of claims 5 and 8-12 as being unpatentable over Gamo. Claim 5 depends from claim 1 and is distinguishable from Gamo for the reasons given above for claim 1. Claims 8-11 depend from claim 1 and are distinguishable from Gamo for the reasons given above for claim 1. Claim 12 depends from amended claim 1 and is distinguishable from Gamo for the reasons given above for amended claim 1. Additionally, the Office has not attempted a *prima facie* case of obviousness of claim 12 over Gamo. Thus, claims 5 and 8-12 are not unpatentable over Gamo.

Gamo in view of Eaglesham

Applicant requests reconsideration of the rejection of claims 2 and 3 as being unpatentable over Gamo in view of Eaglesham et al. Claims 2 and 3 depend from claim 1 as amended and distinguish over Gamo for the reasons given above for amended claim 1. The Eaglesham et al. reference is directed to a process for controlling the diffusion of ion-implanted dopant atoms in a semiconductor layer by incorporating an electrically inactive impurity in the semiconductor layer. Eaglesham et al. also fail to disclose or suggest a silicon segment comprising minority carrier recombination centers having a concentration profile in which the peak density of the centers is at or near the central plane with the concentration generally decreasing from the position of peak density in both the direction of the front surface and the direction of the back surface of the segment. Thus, Eaglesham et al. fail to cure the deficiencies of Gamo, and claims 2 and 3 are therefore patentable over Gamo in view of Eaglesham et al.

Claims 2 and 3 are further directed to a silicon segment having a carbon concentration which is **less than about 1×10^{16} atoms/cm^3 and 5×10^{15} atoms/cm^3** respectively. In contrast, Eaglesham et al. disclose a process for **adding** substitutional carbon within a deposited epitaxial silicon layer. Accordingly, Eaglesham et al. only disclose carbon concentration of an epitaxial layer rather than an entire wafer, and even then, the **background concentration** of carbon prior to addition is **1×10^{18} atoms/cm^3**. Eaglesham et al. then discloses **increasing** the carbon concentrations from this background level to 4×10^{18} atoms/cm^3, 1×10^{19} atoms/cm^3, or even up to 1×10^{20} atoms/cm^3. Therefore, Eaglesham et al. also fail to disclose or suggest a silicon segment having a carbon concentration which is less than about 1×10^{16} atoms/cm^3 or

5×10^{15} atoms/cm^3. Thus, claims 2 and 3 are patentable over Gamo in view of Eaglesham et al.

Temple et al. in view of Gamo and further in view of Eaglesham et al.

Applicant requests reconsideration of the rejection of claims 2 and 3 as being unpatentable over Temple et al. in view of Gamo and further in view of Eaglesham et al. Claims 2 and 3 depend from amended claim 1 and are therefore patentable over Temple et al. in view of Gamo and further in view of Eaglesham et al. for the reasons given above for amended claim 1. Since the Office does not cite Temple et al. for any specific disclosure beyond the disclosure attributed to Gamo and Eaglesham et al. with regard to claims 2 and 3, claims 2 and 3 are also patentable over Temple et al. in view of Gamo and further in view of Eaglesham et al. for the reasons given above for Gamo in view of Eaglesham et al.

Gamo in view of Allman

Applicant requests reconsideration of the rejection of claim 12 as being unpatentable over Gamo in view of Allman. Claim 12 depends from claim 1 as amended and distinguishes over Gamo for the reasons given above for amended claim 1. The Allman reference is directed to a process for polishing a semiconductor wafer. Allman also fails to disclose or suggest a silicon segment comprising minority carrier recombination centers having a concentration profile in which the peak density of the centers is at or near the central plane with the concentration generally decreasing from the position of peak density in both the direction of the front surface and the direction of the back surface of the segment. Since Allman fails to provide a requirement of amended claim 1 which is also absent from Gamo, dependent claim 12 is patentable over Gamo in view of Allman.

Temple et al. in view of Gamo and further in view of Allman

Applicant requests reconsideration of the rejection of claim 12 as being unpatentable over Temple et al. in view of Gamo and further in view of Allman. Claim 12 depends from amended claim 1 and is therefore patentable over Temple et al. in view of Gamo and further in view of Allman for the reasons given above for amended claim 1.

Temple in view of Gamo

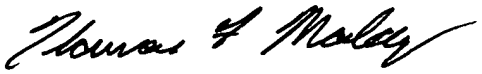
Applicant requests reconsideration of the rejection of claims 4-11 as being unpatentable over Temple et al. in view of Gamo. Claims 4-11 depend from amended claim 1 and are patentable over Temple et al. in view of Gamo for the same reasons given for amended claim 1. Since the Office does not cite Temple et al. for any specific

disclosure beyond the disclosure attributed to Gamo with regard to claims 4-11, claims 4-11 are also patentable over Temple et al. in view of Gamo for the reasons given above with regard to Gamo alone.

CONCLUSION

In view of the foregoing remarks, it is respectfully submitted that claims 1-22 are patentable. Favorable consideration and allowance of all pending claims is requested. Applicants enclose a check in the amount of $410.00 to cover the cost of a two-month extension of time. The Examiner is authorized to charge any underpayment or to credit any overpayment of the above referenced fees to Deposit Account No. 19-1345.

Respectfully submitted,



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